Space Weather Technical Forecast

Issued on Wednesday, 05 July 2023 at 13:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Active fluence declining. R1/R2 radio blackouts likely. G1/Minor Storm to G2/Moderate Storm possible late 06 July or early 07 July with CME arrival.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Moderate, peaking at M1.4 at 04/1235 UTC, originating from AR3354 on the northwest limb. There are currently eight sunspot regions on the visible disc with AR3354 the largest and most complex region. This region is becoming more difficult to analyse as it continues to rotate closer to the limb, therefore the current classification will be maintained as it rotates towards the limb. AR3359 in the south centre disc and AR3361 in the northeast carry the next highest flare risks due to recent slow evolutions. No Earth directed CMEs have been observed on available imagery in the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind as observed at L1, has been at ambient levels, below 400km/s. The density has been mostly below or around average. IMF was weak throughout, at 6 nT or below, while the north-south component varied weakly. The phi angle was predominately positive (away from the Sun), before reorientating to be negative (towards the Sun) by the end of the period. Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as observed by GOES16, was at background levels. High energy electron flux (greater than 2MeV), as observed by GOES16, was at mainly high levels, peaking at 3264pfu at 04/1730 UTC. The 24-hour integrated fluence has been on a flat trend just above the Active threshold throughout. A fluence of 1.52e8 was recorded at 05/0000UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Moderate activity is likely, with a slight chance of further X-class flares. The risk is mostly coming from AR3354 in the northwest. As this region rotates across the limb, the risk falls slightly, but still presents a flare risk from beyond the limb.

Solar Wind / Geomagnetic Activity: A partial halo CME from a filament eruption near AR3359 on 04 July has been analysed and appears to be Earth-directed, with a likely to arrival at Earth either late on the 06 or early on 07 July. Solar wind speeds may increase from ambient levels to around 500-600km/s due to the possible arrival of the connection with a coronal hole high speed stream on 08 July. Depending on the timing of arrival of the CME may mask this connection and produce solar wind speeds of up to 700km/s. Geomagnetic activity is forecast to be mainly Quiet at first, but increasing to Active with a risk of G1 or G2 (Minor or Moderate) storms due to the effects of the CME arrival either late on 06 July or during 07 July. There is also a very slight chance of G3/ Strong storms, but with low confidence. Heightened geomagnetic activity is then expected to the end of the period following either of these events.

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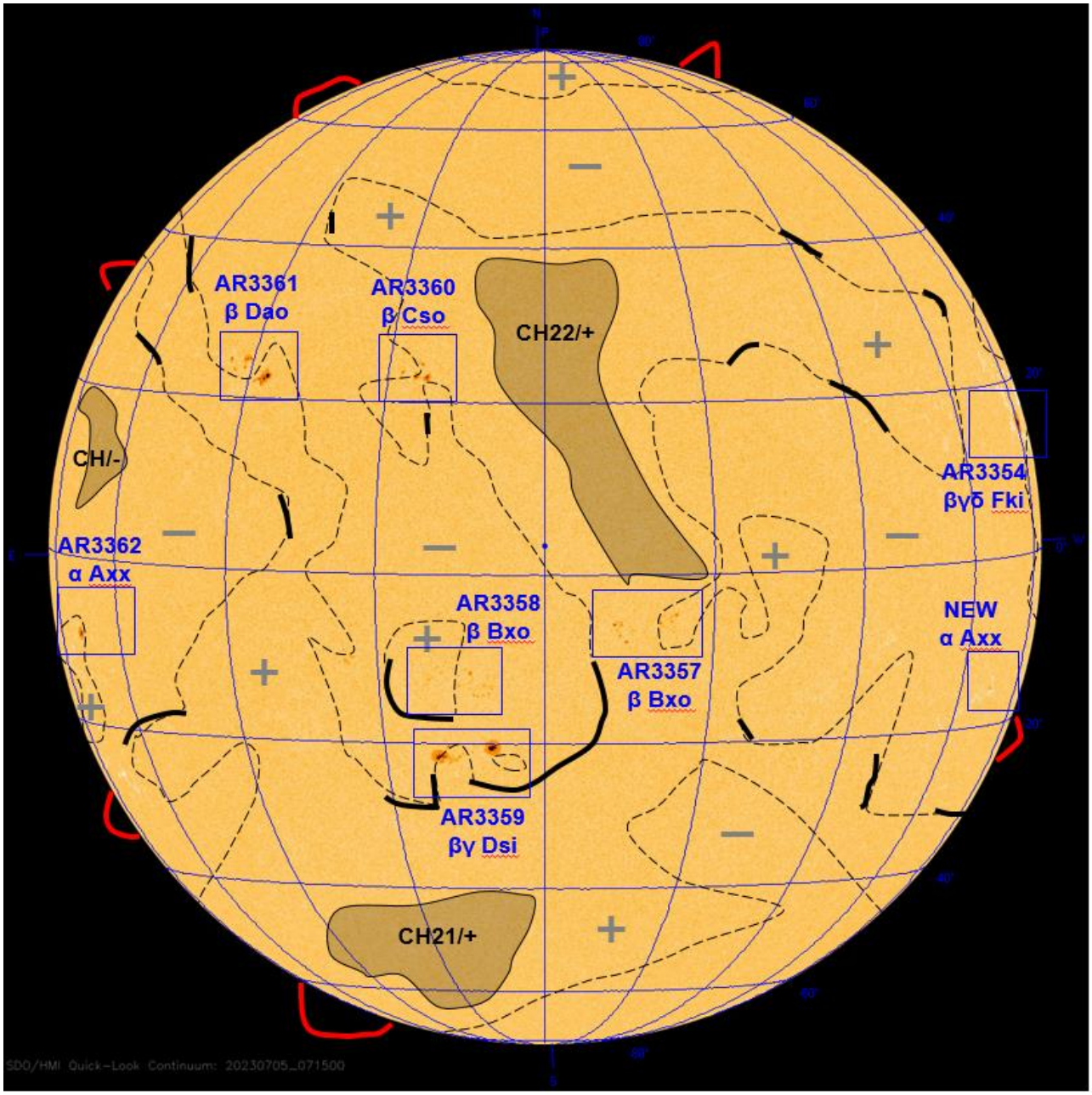
Energetic Particles / Solar Radiation: The high energy (greater than 10MeV) proton flux has a slight but declining chance of reaching the S1/Minor Storm threshold throughout the period. The risk reduces as AR3354 rotates across the northwest limb. High energy electron flux (greater than 2MeV) is expected to decline, with a sharper drop likely as the CME arrives on 06 or 07 July. The corresponding fluence is above the Active (1e8 integrated flux) threshold and is also expected to drop rapidly with the CME arrival.

Figure 1. Solar Analysis Valid 05/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A partial halo CME with a forecast speed of 700km/s left the Sun on 04 July and is forecast to arrive at Earth either late on 06 or early 07 July, with a slight bias towards later in that range. The impacts from the arrival may then build across the remainder of the period.
Solar wind speeds are currently at ambient levels, but are forecast to increase due to a connection to coronal hole 22. This is a persistent feature which produced speeds of 500km/s on the last rotation with a comparable appearance on this rotation. Based on this speed, a connection on 07 July is forecast with speeds in the range 500-600km/s.

Geomagnetic activity is expected to be mainly Quiet on 05 July, increasing to Unsettled to Active, due to the arrival of the forecast CME. There is a likelihood of G1 or G2 (Minor or Moderate) storms, with a slight chance of G3 Strong storms, with the risk higher for the most likely arrival time on 07 July. The connection of the coronal hole may be masked by the CME arrival, although this connection could produce Active intervals should this occur before the CME arrival. Residual effects are then possible through into 08 July.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	40	60	30
Strong	G3	No	1	5	10	5
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
04/1000	Partial	Filament	SE quadrant	700km/s	07/0000UTC +/- 12 hours	G1/G2 shock likely.

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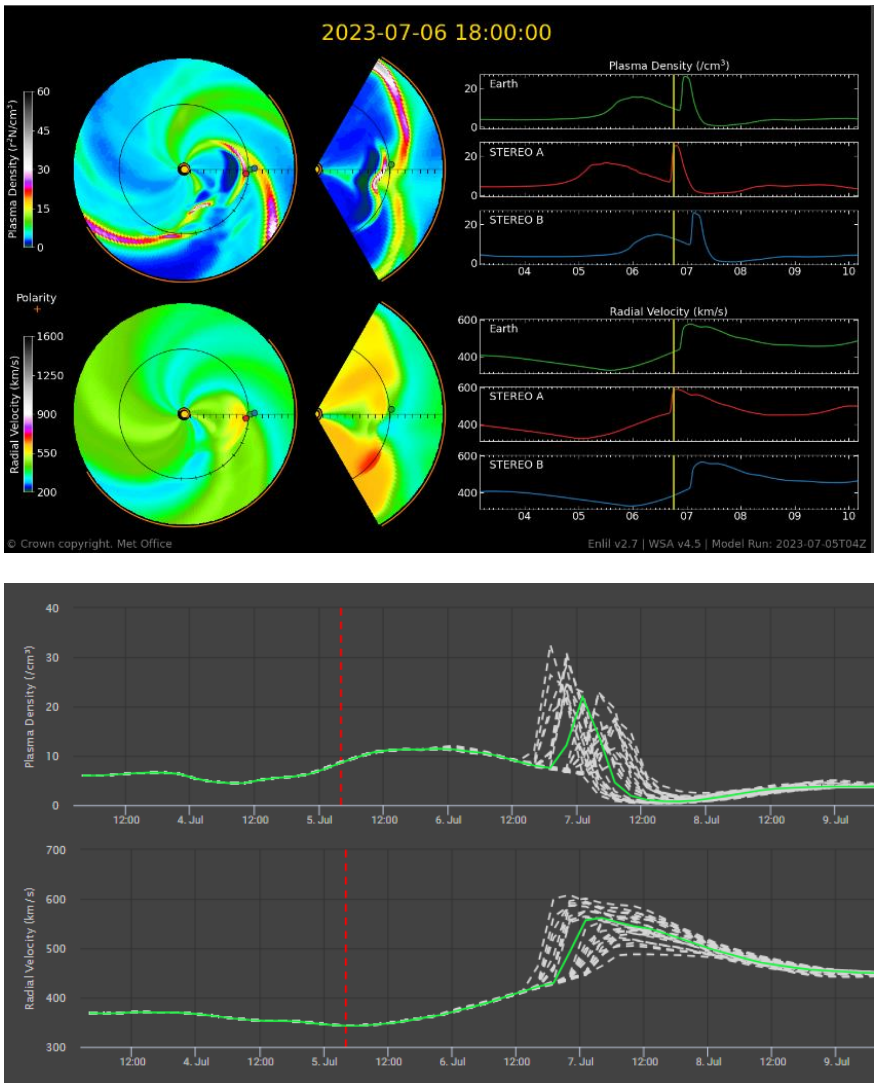
Figure 2: MOSWOC Enlil model showing forecast CME arrival and MOSWOC Enlil ensemble showing possible range of arrival times.



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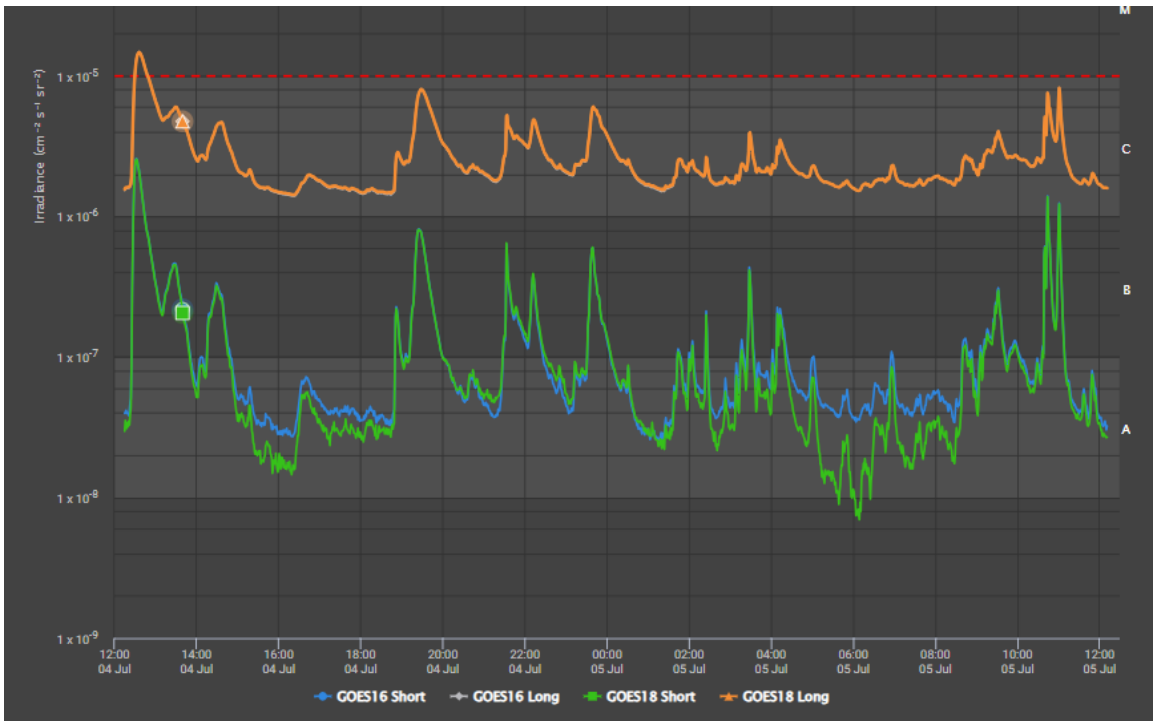
Radio Blackouts - X-Ray Flares:
Solar activity has been Moderate, with only one M-class flare observed from the complex region AR3354. This is now difficult to analyse as it moves onto the solar limb, but is assumed to remain complex, especially based on recent flare activity. This region contained a delta spot on the last comprehensive analysis and will continue to present a flare risk from beyond the limb. AR3359 and AR3361 are also developing regions, but with current unremarkable flare activity. The remaining regions appear small and benign, with no significant flare activity.

Solar activity is forecast to be mainly Moderate, with a slight chance of X-class flares due to AR3354 on the western limb.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	50	40	20
Very Active	R3 to R5 X Class	No	10	10	5	5

Figure 3: GOES 16 X-ray flux



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at background levels. There is a slight but declining chance of S1/Minor storm levels being reached through this period. This is mainly due to AR3354, given its favourable location in the western hemisphere. The risk from this region is now reduced back to previous levels, as there have been no effects seen from the X1 flare on 02 July. Although AR3354 rotates off during 05 July, the risk of radiation storms remains until it is well over the limb.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) will start at mainly high levels, but with a declining peak due to the muted solar wind speeds. The reaction of electron flux to the forecast CME and high speed stream is uncertain, but a geomagnetic storm is likely to result in a redistribution of electrons and a possible distortion of the radiation belts away from GEO orbit.

Based on this there is likely to be a sharp decline in electron counts due to the initial impacts of the CME and high speed stream onset with a slow recovery. Electron fluence is therefore likely to experience a notable fall through 06 and 07 July, with a slow trend towards the Active threshold later in the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	60	30	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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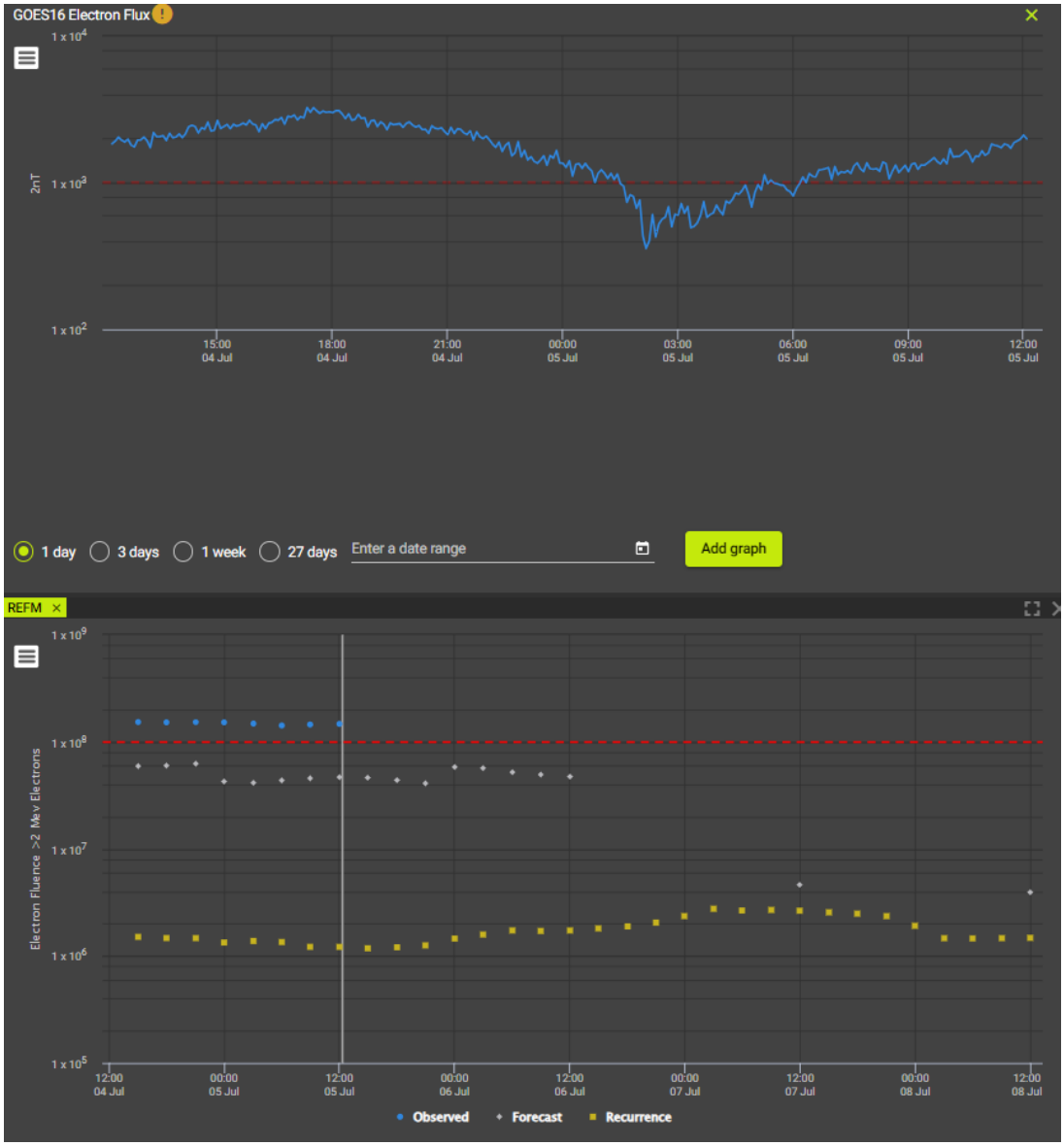
Figure 4: GOES 16 electron flux and MOSWOC REFM model showing possible electron fluence trends.



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